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Studies on the Processing of Red Cherries. II. Some Effects of Bruising on the Yield and Quality of Canned Montmorency Cherries[a]

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The bruising of fresh cherries prior to the soaking period increased both the ratio of drained weight to put-in weight and the tenderometer reading of the canned product. Under the experimental conditions employed, however, bruising had almost no effect on final yield, color, and soluble-solids content. Cherries processed immediately after being picked were comparatively soft and gave a low yield. Storing the cherries either in air or in water for 15 hours at 65° F. increased both their firmness and yield.

Although the procedure of soaking red tart cherries in cold water prior to processing has been in general use for more than 30 years, published information on the effects of this treatment on the subsequent behavior of cherries during processing is relatively scarce. It is commonly believed that soaked cherries may be pitted with less waste and that the pitted fruit "bleeds" less than does fruit not soaked *(5)*. Reynolds and Reynolds *(6)* expressed the opinion that cherries soaked in cold water retain all their natural juices, become firm, and hold their shape well in canning.

Griswold *(1)* found, however, that soaking cherries in cold water caused deterioration in the color of the canned product. The deterioration was proportional to period of soaking. Similar results were obtained by Marshall and co-workers *(4)* who observed also that soaking caused a loss of soluble solids and concluded that soaking was not essential for preventing excessive pitting losses.

Some of the changes that cherries undergo when soaked in cold water have been described previously *(3, 4, 5, 10)*. Whittenberger and Hills *(10)* observed that the changes were dependent in part on the degree of bruising. Bruised cherries did not gain significantly in weight and lost appreciable quantities of soluble solids into the soaking medium. By contrast, unbruised cherries gained steadily in weight and lost only small amounts of soluble solids. Since most lots of commercially handled cherries are rather severely bruised by the time they arrive at the processing plant, the results of this study on bruising should be of interest to cherry processors.

The present paper, an extension of the previous study *(10)*, discusses the effects of bruising and of various cooling and soaking treatments on the pitting losses, yield, and quality of canned cherries.

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MATERIALS AND METHODS

Montmorency cherries were obtained from the Michigan State College orchard at East Lansing and hauled to the fruit-processing laboratory of the Department of Horticulture. The fruit was obtained from 20-year-old trees which had been sprayed with a proprietary copper fungicide, Tennessee 26. The cherries were picked without stems and handled carefully to avoid crushing or bruising. The fruit was picked in the morning and immediately transported to the laboratory, where it was sorted to remove all defective and bruised cherries. Bruised fruit was detected by gently rolling each cherry with one's fingers and noting the lack of turgidity.

In all experiments, the cherries were sorted for maturity on the basis of color. At the harvest stage, most of the cherries were a bright red, but a large number had an orange-red color; some had a dark-mahogany shade. Fruit corresponding to these three color groups was arbitrarily called ripe, under-ripe, and over-ripe, respectively.

Some lots of cherries were bruised by a standard procedure. Each cherry was dropped twice from a height of 3 feet onto a 16-gauge stainless steel pan. Care was taken to avoid dropping the cherries onto other cherries, because this produced less bruising and made for non-uniformity of samples. This extent of bruising seemed equivalent to that observed in many lots of commercially harvested fruit. The bruised cherries were held in trays for 2 hours before soaking or cooling. This allowed some of the juice to exude onto the surface, as it commonly does in commercially handled fruit.

Approximately 2-kg. lots of cherries were weighed into cylindrical wire mesh baskets, 6 inches deep and 10 inches in diameter, and soaked in 6 liters of distilled water in a 12-inch diameter glass cylinder held in a room at 50° F. (10° C.). By starting with water at 42° F. (5.5° C.) the cherries were cooled from about 75 to 50° F. (23.9 to 10° C.) within a few minutes. The cherries were weighed at intervals during soaking. Weighings were made after removing the baskets from the water and allowing the fruit to drain for 5 minutes. The initial weighing was always made after soaking for 10 minutes. This 10-minute soak, or rinse, removed the surface juices and gave the correct net weight for the wet fruit, which could be used as the starting point for determining gain or loss on soaking. Soluble-solids determinations were made on aliquots of the soaking solution by evaporating to dryness.

The cherries were pitted in the same pilot-scale Dunkley pitter used by Marshall *et al. (4)*. Loss in weight due to removal of pits and loss of juice was recorded for each lot. The pitted cherries were canned in No. 2 cherry enamel cans. The "put-in" weight was 444 g. of fruit per can. The cans were exhausted to a center temperature of 165-170° F. (74-76.7° C.), sealed, processed in boiling water for 12 minutes, cooled and stored at 50° F. (10° C.).

After 4 months' storage, the cans were opened, and the cherries were examined for color, soluble solids, texture, and drained weight. The cans were removed from storage one day prior to examination and allowed to warm to room temperature. The color of the supernatant juice, filtered through No. 1 Whatman paper and diluted 1 : 5 with distilled water, was evaluated with a Coleman spectrophotometer, Model 14, set at 440 mμ. Preliminary tests indicated that the red pigment was distributed uniformly between the canned cherries and the surrounding liquid.

The soluble-solids content of juice from representative samples of cherries was determined by an Abbé refractometer, and the values were corrected to 68° F. (20° C.) *(2)*. Drained weight was determined by the standard procedure *(7)* used by the U. S. Department of Agriculture, Production and Marketing Administration. Texture was measured on a 100-g. sample of drained fruit, using scale one on the tenderometer.

RESULTS

Effects of bruising. Table 1 shows in detail the various sources of gain or loss during soaking, pitting, and canning. The data are averages of 11 experiments with cherries treated under similar conditions. In all calculations, the percentages are based on the weight of raw, untreated fruit.

TABLE 1

Effect of bruising on the behavior of cherries during processing [c]

Factor Observed	Unbruised	Bruised
	%	%
Weight of raw, dry cherries	100.0	100.0
Weight after rinse at 50° F.	102.8	102.0
Weight after soaking	107.0	103.0
Gain during soaking	4.2	1.0
Pitting loss, total	17.9	16.3
Pit loss	7.3	7.6
Juice loss	10.6	8.7
Weight of pitted cherries	89.1	86.7
Drained weight/put-in weight	82.5	84.7
Yield of canned cherries (drained-weight basis)	73.5	73.4
Loss of soluble solids in rinse water	0.4 [d]	1.2 [d]
Loss of soluble solids during soaking	2.8 [d]	4.7 [d]
Total loss of soluble solids prior to pitting	3.2 [d]	5.9 [d]

[c] The data are averages of 11 experiments with cherries bruised before being soaked for 22 hours at 50° F.

[d] Percentage of the total soluble solids in the original cherries.

When rinsed in cold water, unbruised cherries picked up 2.8% of surface water, whereas the bruised cherries gained 2.0%. This difference represents juice which had exuded from the bruised fruit. Since these cherries were already partly wetted, they gained only an additional 2.0% of surface liquid. Analysis of a portion of the rinse water from the bruised cherries showed that 1.2% of the total soluble solids was on the surface. After soaking in water at 50° F. (10° C.) for 22 hours, the unbruised and bruised cherries gained in weight an additional 4.2 and 1.0%, respectively.

The pitting losses are divided into two categories: loss of pits and loss of juice. In addition to the juice lost during pitting, an amount equal to about 5% of the weight of the fruit drains out of the tissue within a few minutes after pitting. No further drainage occurs except under certain conditions of bruising, in which case the pitted cherries may "bleed" for several hours. Juice losses from these various sources are combined in the present text and are discussed under only one heading.

The difference in weight between the unbruised and bruised cherries was greatest at the end of the soaking period. This difference tended to diminish during pitting and canning. The pitting losses were greater for the unbruised fruit (17.9%) than for the bruised fruit (16.3%). Although slightly more flesh adhered to the pits of the bruised cherries, the unbruised cherries lost a significantly greater quantity of juice, which, of course, contained soluble solids. Nevertheless, the quantity of freshly pitted fruit favored the unbruised cherries by the margin of 89.1 to 86.7%.

The weight of the unbruised cherries was affected more by heat processing (canning) than was that of the bruised fruit. To illustrate, the ratio of drained weight to put-in weight of the unbruised cherries was 0.825, whereas that of the bruised cherries was 0.847. The over-all yields, however, from the unbruised and bruised cherries were nearly identical. The yields, on a drained weight basis, were obtained by multiplying the weights of freshly pitted fruit by the ratios of drained weight to put-in weight. The ratios alone did not show accurately the final yields (based on the weights of the original fresh, whole cherries).

Soaking caused changes in the soluble-solids content of the cherries by 2 separate processes. In the first place, soluble solids were leached from the cherries into the soaking medium. The unbruised and bruised cherries lost 3.2 and 5.9%, respectively, of their total soluble solids by this process. These losses, of course, decreased the concentration of soluble solids in the cherries. In the second place, the concentration of soluble solids in the tissues decreased because of dilution with water. For instance, the soluble solids in the unbruised fruit was diluted by about 4.2% and that of the bruised fruit by about 1.0% by the uptake of water during 22 hours of soaking. On a concentration basis, therefore, the soluble-solids contents of the unbruised and bruised cherries were not much different. The bruised cherries showed the greater decrease due to leaching, but the unbruised cherries decreased more by dilution. From a practical standpoint, this means that the unbruised cherries retained nearly all their original soluble solids, whereas the bruised fruit lost appreciable quantities of soluble solids by diffusion; this loss was not recoverable.

Table 2 gives data on the quality of unbruised and bruised cherries after canning. In the lower half of the table, the data are recalculated to the basis of equal drained weights. In commercial practice, the put-in weight usually is adjusted to give the drained weight (13.5 oz. for No. 2 cans) recommended for U. S. Grade A. To attain this drained weight, 16.36 ounces of freshly pitted unbruised cherries would be required, whereas only 15.94 ounces of the bruised cherries would be needed. The increase in tenderometer reading (from 21.5 to 25.2) caused by bruising probably represents an improvement in quality, since many canned cherries are too soft. The color of the processed product, as indicated by the percent transmittance of the juice, was not significantly changed by bruising the raw cherries. A slight over-all loss of soluble solids was associated with bruising.

Effects of maturity and bruising. The effect of maturity on the behavior of unbruised and bruised cherries was studied, following the separation of one lot of cherries into three maturity groups. The cherries were picked from the same tree within a period of 2 hours, and the separation was made on the basis of color. Each of the 3 groups was divided into 2 samples, one of which was purposely bruised and the other left unbruised. These 6 samples were soaked in water at 50° F. (10° C.) for 23 hours before being pitted and canned.

TABLE 2

Effect of bruising on the quality of canned cherries [e]

Factor Observed	Unbruised	Bruised
Put-in weight, ozs.	15.63	15.63
Drained weight, ozs.	12.89	13.24
Ratio of drained weight to put-in weight	.825	.847
Tenderometer reading, lbs. per sq. in.	21.5	25.2
Color, transmittance at 440 mμ, %	40.4	39.5
Soluble solids, %	11.2	10.9
Data above corrected to 13.5 ozs. drained weight		
Calculated put-in weight required, ozs.	16.36	15.94
Color, transmittance at 440 mμ, %	38.8	38.8
Soluble solids, %	11.7	11.1

[e] The data are averages of 11 experiments with cherries bruised before being soaked for 22 hours at 50° F. Cans were stored for 4 months at 50° F.

The soluble-solids contents of the fresh unbruised cherries were 12.1, 14.5, and 15.3% for the immature, ripe, and over-ripe groups, respectively (Table 3). During soaking, the over-ripe cherries gained the most weight (4.4%), and the corresponding immature cherries gained the least (3.7%). In the processed cherries, however, differences in drained weight associated with maturity were small and probably insignificant. The ratios of drained weight to put-in weight were 0.824, 0.820, and 0.813, respectively, for the immature, ripe, and over-ripe fruit. The corresponding over-all yields were 74.7, 71.8, and 72.4%. There was no apparent relationship between the yield of processed cherries and the soluble-solids content of the 3 groups. The color of the processed product in terms of transmittance of the diluted supernatant juice, ranged from 58% for the immature to 31% for the over-ripe fruit.

TABLE 3

Effect of maturity and bruising on drained weight and yield of canned cherries

Cherries and treatment [f]	Raw cherries: Gain in wt. during soaking	Raw cherries: Soluble solids before soaking	Canned cherries: Soluble solids	Canned cherries: Color (transmittance)	Canned cherries: Ratio of drained wt. to put-in wt.	Canned cherries: Yield
	%	%	%	%		%
Immature						
unbruised	3.7	12.1	9.7	58.0	.824	74.7
bruised	0.8	12.1	9.8	53.5	.858	72.8
Ripe						
unbruised	3.9	14.5	11.2	40.0	.820	71.8
bruised [g]	1.7	14.5	11.0	39.5	.847	74.5
Over-ripe						
unbruised	4.4	15.3	11.7	31.0	.813	72.4
bruised	0.5	15.3	11.8	27.5	.838	71.8

[f] All cherries were picked from the same tree within 2 hours and were soaked for 23 hours at 50° F. The three maturity groups were obtained by sorting the cherries on the basis of color.

[g] This sample was bruised by dropping the cherries once from a height of 3 feet. The other bruised samples were dropped twice from 3 feet.

Cherries of the 3 maturity groups responded to bruising in approximately the same manner. Bruising lessened the gain in weight during the soaking period, increased the ratio of drained weight to put-in weight, and slightly intensified the red color. The effects of bruising on yield, however, were inconclusive. The bruising treatment given the ripe cherries was less severe than that given the other samples. Data shown in Table 3 are from a single experiment.

Effects of cooling, soaking, and storing the cherries. During our studies, it was observed that the firmness of freshly picked cherries gradually increased, even though the cherries were given no experimental treatment. If cherries were compressed in a pressure tester *(8)* immediately after being picked, an appreciable quantity of juice exuded from them. If the cherries were held in air for 3 or 4 hours, however, the same pressure caused no exudation of juice. This observation suggested the following experiment, in which some cherries were pitted and processed within 2 hours after being picked, and others stored in air or in water for 15 hours before being processed.

The pitting loss (18.3% at about 75° F.) from freshly picked fruit was relatively high (Table 4). Storing the cherries in air at 65° F. (18.3° C.) for 15 hours reduced their pitting loss to 15.3%. On the other hand, soaking the cherries in water at 65° F. for 15 hours increased their pitting loss to 19.2%. Cherries bruised before soaking, and others that were bruised after soaking, had lower pitting losses than similar unbruised soaked cherries.

The pitting loss from soaked cherries cannot logically be compared with the loss from the original cherries, because the 2 samples differed in age. By comparing the behavior of soaked cherries with the behavior of similar cherries stored in air, the effect of age is at least partly cancelled out, and the increase in pitting loss attributable to soaking becomes apparent. The effect of temperature alone on pitting loss is not indicated reliably by the data of this experiment, since it is not possible to distinguish between the effects of temperature and aging. Some of the changes in cherries associated with aging have been described previously *(9, 10)*.

Storing the raw cherries in air or in water for 15 hours at 65° F. (18.3° C.) increased both the yield of the canned product and the tenderometer reading. Increases were greater with the soaked cherries than with the cherries stored in air. The soaked cherries, however, decreased in soluble-solids content, whereas there was no change in the soluble-solids content of the fruit stored in air. None of the cherries changed appreciably in color during the 15-hour treatment.

A number of observations may be made concerning cherries which were of the same post-harvest age but which were stored at different temperatures. Cherries stored in air or in water at 35° F. (1.7° C.) gave lower average yields, ratios of drained weight to put-in weight, and tenderometer readings than did similar cherries stored at 65° F. For instance, the average yields of all cherries stored at 35, 50, and 65° F. were 72.3, 73.7, and 74.7%, respectively, and the corresponding average tenderometer readings were 25.9, 26.0, and 27.5. Cherries stored (in air or in water) at 35° F. were relatively stable, and their behavior during processing approximated that of the original fruit. The greatest changes occurred in the samples stored at 65° F. Bruising the cherries, either before or after soaking, made almost no difference in the yield of processed fruit, although bruising did increase the tenderometer reading. Bruising produced no cull cherries in any of the experiments reported in this paper.

TABLE 4

Effects of soaking, temperature, storage in air, and bruising on the yield and quality of canned cherries

Treatment of raw cherries [h]	Pitting loss [i] (raw cherries)	Soluble solids	Tenderometer reading	Color (transmittance)	Ratio of drained wt. to put-in wt.	Yield
None. Processed 2 hrs. after harvest.	%	%	lbs./in.^{2}	%		%
About 75° F.	18.3	11.5	23.1	41.0	.881	72.1
Stored in air						
35° F.	15.0	11.4	26.8	40.0	.847	71.6
50° F.	13.9	11.1	25.5	40.0	.858	73.6
65° F.	15.3	11.5	25.7	40.0	.877	73.6
Soaked in water						
35° F.	18.5	11.2	23.0	40.0	.847	73.2
50° F.	17.8	11.2	23.5	40.0	.842	74.2
65° F.	19.2	11.2	27.3	40.5	.856	75.2
Bruised and soaked						
35° F.	17.8	11.0	25.0	40.0	.865	73.1
50° F.	16.2	11.0	31.1	39.5	.854	73.2
65° F.	17.1	11.2	29.9	40.5	.878	74.7
Soaked and bruised						
35° F.	17.8	11.2	28.7	40.5	.833	71.4
50° F.	17.7	11.1	24.0	40.5	.842	73.6
65° F.	16.9	11.0	26.9	41.0	.852	75.1

[h] The duration of treatments was 15 hours.

[i] The cherries were not pitted at a constant temperature.

DISCUSSION

Although the present study shows that bruising fresh cherries definitely affected their behavior during processing, bruising was studied only under a relatively narrow set of conditions. By contrast, bruising in commercial practice occurs under a wide range of conditions. Cherries may be bruised as they are picked, as they are dumped into lug boxes, as they are loaded and hauled to the processing plant, and as they are soaked, sorted, and conveyed throughout the plant. They may be held for irregular intervals at varying temperatures between the periods of bruising. It would not be proper, therefore, to interpret the effects of bruising in all or even in the majority of commercial cherries in terms of the present results. It is probable that bruising in commercial practice has several different effects, depending largely on the total post-harvest history of the various samples. Conditions have been described *(9)*, for instance, under which bruising may result in either an increase or decrease in the yield of final product. Similar differences in the effects of bruising on color, color defects, texture, soluble-solids content and flavor may occur also.

Effects of temperature and storage on the behavior of cherries during processing also were studied under only a relatively few experimental conditions. It might be expected, for instance, that greater differences among the samples of Table 4 would have been obtained if the experiment had been permitted to run for 30 hours instead of 15. In commercial practice, occasional lots of cherries are held for 48 hours or more between the times of harvesting and processing. Obviously, further studies on the effects of bruising, cooling, and storing cherries are desirable.

SUMMARY

Although unbruised cherries gained weight when soaked in cool water and bruised cherries showed little if any gain, the final yields of canned fruit from the unbruised and bruised samples were similar. The gain of the unbruised cherries was lost during pitting and canning.

Bruising the raw cherries increased both the ratio of drained weight to put-in weight and the tenderometer reading of the processed fruit. The ratio was not a valid criterion of yield, as based on the weight of the original whole, fresh cherries. Under the experimental conditions employed, bruising had only a slight effect, if any, on the color and soluble-solids content of the final product.

Cherries ranging in color from orange to mahogany red and in soluble-solids content from 12.1 to 15.3% were picked from a single tree on the same day. There was no relationship between maturity (as based on color) and drained weight, and all cherries responded to bruising in approximately the same manner.

Cherries processed immediately after being picked gave both a low tenderometer reading (cherries were soft) and a low yield of canned fruit. Storing the fresh cherries in air or in water at 65° F. (18.3° C.) for 15 hours increased the tenderometer reading and the yield. Fruit stored at 35° F. (1.7° C.) for 15 hours gave tenderometer readings and yields not much different from those of the original fruit. Although fruit stored in air had the lower pitting loss, fruit soaked in water gave the higher yield of final product.

In conclusion it may be stated that although bruising affected the behavior of cherries during various processing steps, it had no effect on final yield and only a slight effect on quality.

LITERATURE CITED

1. Griswold, Ruth M. Factors influencing the quality of home-canned Montmorency cherries. Mich. State College Agricultural Experiment Station *Tech. Bull.* 194 (1944).
2. International Critical Tables, II, 339, McGraw-Hill Book Co., Inc., New York (1927).
3. Langer, C. A., and Fisher, V. J. Relation of wax emulsion and fungicidal sprays to size, color, and composition of fresh and processed Montmorency cherries. *Proc. Am. Soc. Hort. Sci.*, **54**, 163 (1949).
4. Marshall, R. E., Robertson, W. F., Bedford, C. L., and Case, W. H. The effect of the length of soak on the quality of canned and frozen Montmorency cherries. *Food Technol.*, **5**, 116 (1951).
5. Peterson, G. T. Changes in red sour cherries resulting from soaking. *Fruit Products J.*, **17**, 172 (1938).
6. Reynolds, Karl S., and Reynolds, D. W. Modern methods of producing, handling and canning red sour cherries. *Canner,* **66**, 17, 19 (1928).
7. U. S. Standards for grades of canned red sour (tart) pitted cherries. United States Department of Agriculture, Production and Marketing Administration, June 1949 (Mimeograph).
8. Whittenberger, R. T., and Marshall, R. E. Measuring the firmness of red tart cherries. *Food Technol.*, **4**, 311 (1950).
9. Whittenberger, R. T. Factors which affect the drained weight and other characteristics of heat processed red cherries. *Food Research,* **17**, 299 (1952).
10. Whittenberger, R. T., and Hills, Claude H. Studies on the processing of red cherries. I. Changes in fresh red cherries caused by bruising, cooling and soaking. *Food Technol.*, **7**, 29 (1953).